Solid-State Switch Replacements for Ignitrons

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Ignitron-type power-pulsed switches, often used for high-current handling, pose problems associated with mercury hazards, auxiliary cooling, shock limits, and reliability in field deployments. Transitioning to solid-state technology offers advantages in many applications, but demonstration of performance is needed for acceptance. The goal of this project is to evaluate the newest commercially available solid-state switches beyond manufacturers' ratings, to determine limits of high current and high dI/dt for short pulse durations, and to evaluate suitability for LLNL's pulsed power applications.

Project Goals

The goals of this project included 1) the demonstration of a 10-kV, 20-kA solid-state replacement for the ignitron used at LLNL's Big Experimental Explosive Facility (BEEF); and 2) providing a basis for a 30-kV, 500-kA series/parallel solid-state switch for BEEF, NIF, and the Environmental Measurements Laboratory (EML).

Relevance to LLNL Mission

Among the many applications at LLNL for high current/energy capacitive discharge units (CDUs) are: magnetic flux compression generators (DNT); flashlamp banks (Lasers/NIF); pulsed high-field magnets (Sustained Spheromak Physics Experiment (SSPX)); EM Launchers/Rail Guns (NAVY); and compact electric power conversion.

FY2006 Accomplishments and Results

Six state-of-the-art commercial thyristors (8 kV, 90 kA) were procured for evaluation. A general purpose high-current (>100 kA) testbed has been

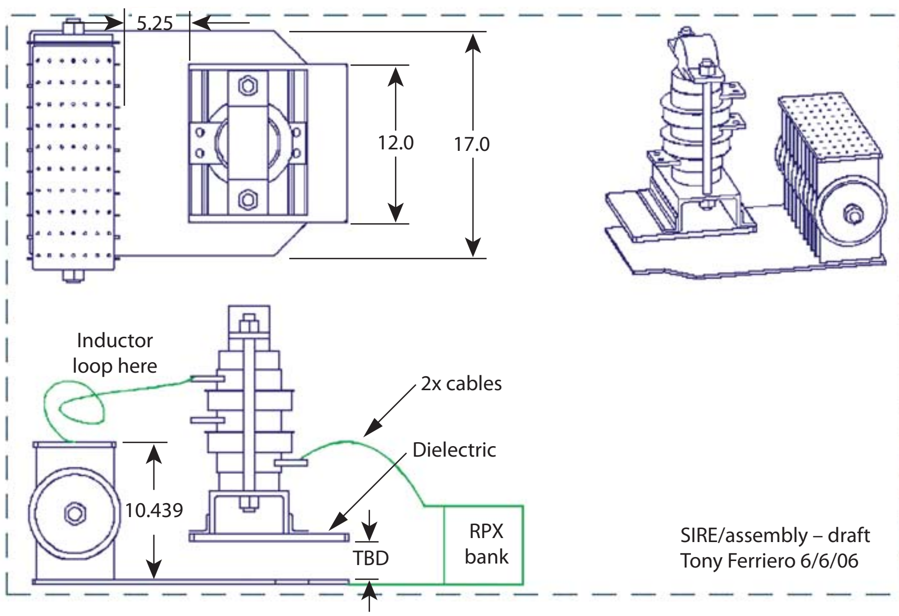

Figure 1. Mechanical drawing of testbed.

constructed that is capable of testing a wide range of solid-state switch components. Initial high-voltage/low-current "leakage" testing has been completed. Figures 1 to 3 illustrate our system and set-up.

Related References

1. Arnold, P. A., "Solid-State Replacements for Hydrogen Thyratrons," http://www-eng.llnl.gov/pdfs/lsr_sys_opt-3.pdf

2. Erickson, R. W., and D. Maksimovic, Fundamentals of Power Electronics, Kluwer, Academic Publishers, United Kingdom, 2001.

3. Williams, B.W., Power Electronics: Devices, Drivers, Applications and Passive Components, McGraw-Hill, New York, New York, 1992.

4. Kassakian, J., M. Schlecht, and G. Verghese, Principles of Power Electronics, Addison-Wesley, Reading, Massachusetts, 1991.

FY2007 Proposed Work

We plan to conduct tests on a unit procured in FY2006 and create a reliable "operational envelope" for pulse power applications by operating the units beyond the manufacturer's specifications for peak current and dI/dt. We will investigate both series and parallel operation of the devices to extend both peak voltage and current capabilities.

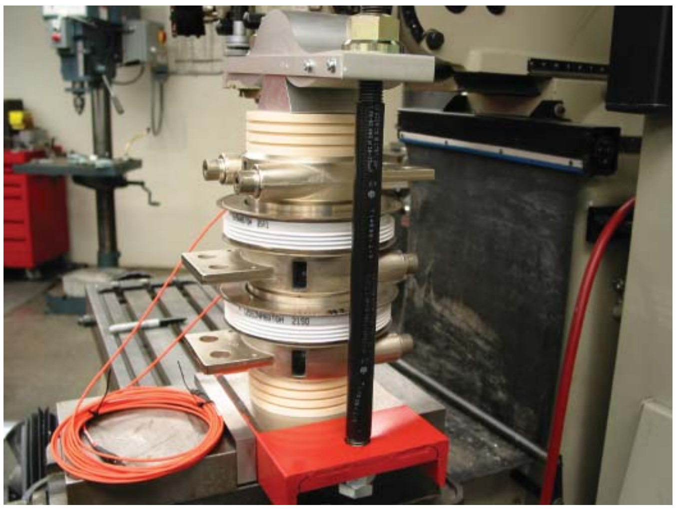

Figure 2. Assembled 2-thyristor stack.

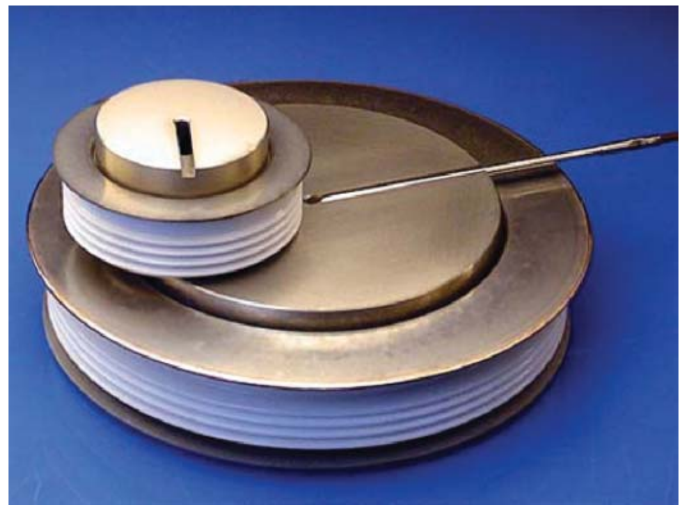

Figure 3. Light-triggered thyristors.